LISTING OF CLAIMS

1. (original) An imaging system for examining specimens comprising:

a) a video microscope comprising:

ai) a holder for specimens; and

aii) a camera located so as to be focussed on said holder;

b) a light source operatively connected to said video microscope;

c) a robotic system operatively connected to and for positioning said video microscope;

d) a computer operatively connected to both said camera and to said robotic system, said computer having operating programs comprising routines for providing machine vision techniques for scanning, identifying, detecting and tracking selected characteristics and features of said specimen.

2. (original) The imaging system according to claim 1, wherein said light source is a fiber-optic light source.

3. (original) The imaging system according to claim 1, wherein said camera has charged-coupled devices comprising its head and which are operatively connected to said computer by an image acquisition board.

4. (original) The imaging system according to claim 1, wherein said operating programs further comprise routines for controlling said robotic system which, in turn, controls positioning of said video microscope which, in turn, controls positioning of said camera.

5. (original) The imaging system according to claim 1, wherein said operating programs further comprise algorithms which operatively cooperate with said routines for scanning, identifying, detecting and tracking selected characteristics and features of said specimen.

6. (original) The imaging system according to claim 1, wherein said operating programs further comprise neural network routines, which operatively control said robotic system.

7. (original) The imaging system according to claim 4, wherein said robotic system provides three (3) dimensional positioning of said video microscope which, in turn, provides three (3) dimensional positioning of said specimen being held in said holder.

8. (original) The imaging system according to claim 1, wherein said robotic system comprises a platform for holding and orienting said video microscope.

9. (original) The imaging system according to claim 1, wherein said computer comprises a display terminal.

10. (original) An imaging system for examining specimens comprising:

a) a video microscope comprising;

ai) a holder for specimens; and

aii) a camera located so as to be focussed on said holder and providing an output representative of the electronic image of said held specimens;

b) a light source operatively connected to said video microscope for illuminating said specimens being held in said holder;

c) a robotic system responsive to electrical signals and operatively connected to and for positioning said video microscope;

d) a computer having a display terminal and operatively connected to said output of said camera and providing said electrical signals to said robotic system, said computer having operating programs comprising routines for providing machine vision techniques for scanning, identifying, detecting and tracking, and displaying on said display terminal selected characteristics and features of said specimen.

11. (original) The imaging system according to claim 10, wherein said light source is a fiber-optic light source.

12. (original) The imaging system according to claim 10, wherein said camera has charged-coupled devices comprising its head and providing said electronic image which is operatively connected to said computer by an image acquisition board.

13. (original) The imaging system according to claim 10, wherein said operating programs further comprise routines for controlling said robotic system which, in turn, controls positioning of said video microscope which, in turn, controls positioning of said camera.

14. (original) The imaging system according to claim 10, wherein said operating programs further comprise algorithms which operatively cooperate with said routines for scanning, identifying, detecting and tracking selected characteristics and features of said specimen.

15. (original) The imaging system according to claim 10, wherein said operating programs further comprise neural network routines, which operatively control said robotic system.

16. (original) The imaging system according to claim 13, wherein said robotic system provides three (3) dimensional positioning of said video microscope which, in turn, provides three (3) dimensional positioning of said specimen being held in said holder.

17. (original) The imaging system according to claim 10, wherein said robotic system comprises a platform for holding and orienting said video microscope.

18. (original) A method for examining specimens comprising the steps of:

a) providing a video microscope having a holder for specimens and a camera located so as to be focussed on said holder and providing an output representative of the electronic image of said specimen;

b) providing a light source operatively connected to said video microscope for illuminating said specimens being held in said holder;

c) providing a robotic system responsive to electrical signals and operatively connected to and for positioning said video microscope;

d) providing a computer having a display terminal and operatively connected to said output of said camera and providing said electrical signals to said robotic system, said computer having operating programs comprising routines for providing machine vision techniques for scanning, identifying, detecting and tracking and displaying on said display terminal selected characteristics and features of said specimen.

19. (original) The method according to claim 18, wherein said light source is a fiber-optic light source.

20. (original) The method according to claim 18, wherein said camera has charged-coupled devices comprising its head and providing said electronic image which is operatively connected to said computer by an image acquisition board.

21. (original) The method according to claim 18, wherein said robotic system provides three (3) dimensional positioning of said video microscope which, in turn, provides three (3) dimensional positioning of said specimen being held in said holder.

22. (original) The method according to claim 21, wherein said operating programs further comprise routines for controlling said robotic system which, in turn, control positioning of said video microscope.

23. (original) The imaging system according to claim 18, wherein said operating programs further comprise algorithms which operatively cooperate with said routines for scanning, identifying, detecting and tracking selected characteristics and features of said specimen.

24. (original) The method according to claim 18, wherein said routines for providing machine vision techniques comprise a routine for interface detection of colloid hard spheres comprising the steps of:

a) placing a colloidal hard sphere specimen having a solid/liquid interface to be examined in said holder;

b) causing said video microscope to generate an electronic image serving as a frame of said colloid specimen;

c) examining said frame of said electronic image to determine if the solid/liquid interface has a horizontal or vertical crystal growth;

d) generating a series of frames of said electronic image;

e) performing averaging of said frames to provide image averaged over said series of frames so as to visually separate solid and liquid portions of said electronic image; and

f) examining by displaying said averaged image to identify said liquid portions by blurred or grayed out regions of said averaged image and to identify said solid portions as clear regions with contrast therein.

25. (original) The method according to claim 18, wherein said routines for providing machine vision techniques comprise a routine for interface detection of colloidal hard spheres comprising the steps of:

a) placing a colloid hard sphere specimen having a solid/liquid interface to be examined in said holder;

b) causing said video microscope to generate an electronic image serving as a frame of said colloid specimen;

c) examining said electronic image to determine the origin size of pixels representing particles of said colloidal specimens;

d) examining said frame of said electronic image to determine if the solid/liquid interface has a horizontal or a vertical crystal growth;

e) generating a series of frames of said electronic image;

f) perform averaging of said frames to provide image averaged over said series of frames so as to visually separate solid and liquid portions of said electronic image;

g) performing a dilation algorithm that restores the size of the pixels of the particles of averaged image to the original size of the particles of the electronic image;

h) performing a threshold algorithm having a predetermined cut-off value on the averaged image with the restored original sized particles to yield a dilated and threshold treated electronic image; and

i) examining by displaying said dilated and threshold treated electronic image to identify said solid and liquid portions each manifesting a separate pattern.

26. (original) The method according to claim 25, further comprising the steps of:

j) superimposing a contrast line on the interface between said separate patterns;

k) examining said contrast line to define data representative of said contrast line; and

l) storing said date in a data base associated with said colloid hard sphere.

27. (withdrawn) The method according to claim 18, wherein said robotic system is a Cartesian robotic system and wherein said video microscope has a camera and wherein said routines for providing machine vision techniques comprise a routine for automatically focussing on a specimen comprising the steps of:

a) attaching to said Cartesian robotic system a micro-positioner having a vertical axis with a top limit and a three (3) stage arrangement, coarse, medium and fine each having a defined step size;

b) placing said specimen being examined in said holder;

c) causing said video microscope to generate an electronic image comprised of spatial frequencies, wherein each spatial frequency being the rate of brightness transition;

d) performing a Fast Fourier Transform (FFT) on said electronic image so as to decompose said electronic image into its fundamental frequency components with each component having magnitude and phase quantities, said FFT performing transforming said electronic image from a spatial domain to a frequency domain;

e) examining said FFT electronic image by displaying the magnitudes of the frequency components;

f) positioning the vertical axis of said micro-positioner to its top level so that said camera is located away from said specimen by a first predetermined distance;

g) positioning in separate steps said micro-positioner so that said camera moves downward and toward said specimen at a predetermined number of step sizes of said coarse stage, while at the same time examining that the FFT pattern being displayed becomes further dispersed as said camera moves downward by each of said course steps;

h) determining the sum of the magnitude of the FFT patterns, while at the same time determining that the sum of the magnitudes decreases as said camera moves downward by each of said course steps;

i) repeating steps g) and h) for said micro-positioner at the defined step size of said medium stage; and

j) repeating steps g) and h) for said micro-positioner at the defined step size of said fine stage so that said electronic image is focussed with desired contrast.

28. (withdrawn) The method according to claim 27, wherein steps g) and h) are repeated before step i) thereof with said repeating being done with said coarse defined step size being decreased by a factor of about ten (10).

29. (withdrawn) The method according to claim 27, wherein said predetermined number of step sizes of said coarse stage is ten(10) and each step size of said coarse step is about 10mm.

30. (withdrawn) The method according to claim 18, wherein said routines for providing machine vision techniques comprise a routine for cell identification and classification including metrics/statistics of one or more cells within an electronic image comprising the steps of:

a) placing said one or more cells comprising a specimen in said holder;

b) causing said video microscope having a camera to generate a series of electronic images of said specimen;

c) generating a histogram having bars which are proportional to the values of the intensity of the series of generated electronic images;

d) performing a Sobel filtering operation of said histogram so as to highlight the edges of the changes in intensity of said histogram;

e) performing a threshold algorithm having a predetermined cut-off value on said histogram having said Sobel filtering so as to eliminate relatively small intensity changes of said histogram having said Sobel filtering;

f) causing said video microscope to generate an electronic image of said specimen;

g) performing a variance (s) filtering operation of said electronic image of said step f) wherein the variance, s, is computed as:

$s^2 = \frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2$, where N is the number of pixels occupying neighborhoods and $\bar{x}$ is the average number of pixels in each neighborhood and wherein said pixels include a center pixel;

h) examining the variance of the neighborhood of the center pixel and establishing the color of its center and if the variance is below a first predetermined variance then setting the color of its center pixel to a color black, but if the variance is above a second predetermined variance the color of its center pixel is left unchanged;

i) combining said histogram of said step e) with the colored or unchanged colored center pixel of step h);

j) performing a find particles technique to identify all the non-background objects in said combined histogram and colored or uncolored center pixel;

k) performing an overlap on said combined histogram and colored or uncolored center pixel of said step j) so as to block out background objects thereof;

l) analyze said non-background objects to produce metrics thereof; and

m) comparing said produced metrics against known metrics so as to identify and classify said one or more cells.

31. (withdrawn) The method according to claim 30, wherein said metrics of said identified and classified one or more cells comprise their major axis, minor axis, area, elongation, roundness, theta which represents an orientation with respect to a predetermined coordinate, thinness, and whether the object of the respective one or more cells being examined is within the field of view of said camera of said video microscope or only partially contained within the field of view of said camera of said video microscope.

32. (withdrawn) The method according to claim 18, wherein said routines for producing machine vision techniques comprise a routine that identifies one or more cells in an area of interest, which cell is closest to the center of the area of interest, the nearest neighbors of each cell within the area of interest, and track movement of the cells within the area of interest; said routine for said identification of all cells comprises the steps of:

a) placing said one or more cells comprising a specimen in said holder;

b) causing said video microscope to generate an electronic image of said one or more cells, each of said one or more cells of said electronic image having a dark outer ring;

c) examining said dark outer ring of each cell so as to determine the shape and size of each of said one or more cells; and

d) performing an intensity weighted center of mass technique utilizing the shape and size of each cell to determine the center of each cell which, in turn, defines the position of each cell relative to each other, wherein the area enclosing the positions of the one or more cells along with outer ring of each cell defining the perimeters of the one or more cells determines said area of interest.

33. (original) The method of claim 18, wherein said video microscope has a camera and wherein said routines for providing machine vision techniques comprise a routine for evaluating surfaces of devices comprising the steps of:

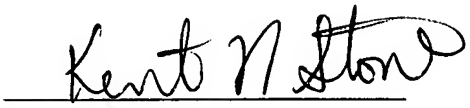
a) providing an electronic image serving as a desired for said devices and possessing an intensity representative of a critical value of said desired surface;

b) placing said device in said holder so that the surface of said device being evaluated is facing said camera of said video microscope;

c) causing said video microscope to generate an electronic image of the surface of said device being evaluated and possessing an intensity representative of said surface of said device being evaluated; and

d) examining the electronic image of the surface of said device being evaluated to determine if the intensity thereof equals or exceeds the critical value of said desired surface and, if so, classifying said surface of said device being evaluated as being unacceptable.

Respectfully submitted,



Kent N. Stone
Registration No. 31,883
Attorney for Applicant

NASA Glenn Research Center; Mail Stop 500-118
21000 Brookpark Road
Cleveland, Ohio 44135

tel: (216) 433-8855
fax: (216) 433-6790